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Some Essential Differences between Consciousness and Attention, Perception, and Working Memory

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When ''divided attention'' methods were discovered in the 1950s their implications for conscious experience were not widely appreciated. Yet when people process competing streams of sensory input they show both selective processes *and* clear contrasts between conscious and unconscious events. This paper suggests that the term ''attention'' may be best applied to the *selection and maintenance* of conscious contents and distinguished from consciousness itself. This is consistent with common usage. The operational criteria for selective attention, defined in this way, are entirely different from those used to assess consciousness. To illustrate the scientific usefulness of the distinction it is applied to Posner's (1994) brain model of visual attention. It seems that features that are often attributed to attention—like limited capacity—may more accurately be viewed as properties of consciousness.

1. INTRODUCTION

Scientific terms are not given in nature. They are worked out, often over generations of data collection and debate. This is relevant especially for a concept like ''consciousness,'' because it is so often conflated with co-occurring but distinguishable terms. During the era of behaviorism psychologists made a major effort to purge psychology of everyday psychological terms, because their meanings and empirical conditions were imprecise and confusing. As Watson (1919) wrote,

> If I were to ask you to tell me what you mean by the terms you have been in the habit of using I could soon make you tongue-tied with contradictions. I believe I could even convince you that you do not know what you mean by them. You have been using them uncritically as a part of your social and literary tradition. (p. 6)

The ''cognitive revolution'' of 20 years ago brought back much of the psychological vocabulary expelled during behaviorism, but now defined with much improved operational rigor (Baars, 1986). Yet there is still room for improved conceptual clarity. One remaining question is how our current crop of psychological terms relate to one another. Is ''attention'' the same as ''consciousness''? How is consciousness related to ''working memory (WM)'' and ''perception''?

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2. THE DIFFERENCE BETWEEN ATTENTION AND CONSCIOUSNESS

English makes a clear distinction between ''looking'' and ''seeing,'' ''listening'' and ''hearing,'' and ''touching'' and ''feeling.'' The first word of each pair describes a way of *gaining access to* a conscious perceptual experience (looking, listening, touching), while the second refers to the resulting experience itself (seeing, hearing, feeling). We use the first verb of each pair in order to become conscious of the second: We *look* in order to *see; listen* in order to *hear,* and *touch* in order to *feel.* The distinction is between selecting an experience and being conscious of the selected event. In everyday language, the first word of each pair involves attention; the second involves consciousness.

It seems that common sense conceives of attention as something more obviously active and controllable than consciousness, while consciousness itself seems to be viewed as a receptive taking in of information from the world. It is as if attention resembles selecting a desired television program, and consciousness is what appears on screen. In point of scientific fact, consciousness all by itself is profoundly active, as shown by the brain processes associated with it (e.g., Leopold & Logothetis, 1996). Yet the attention/consciousness distinction embodies the insight that there are *access control mechanisms* that determine what will or will not become conscious.

Eye movements provide a concrete example. The human brain comes equipped with an extensive set of mechanisms to control the direction of gaze. That system is essential, because our conscious experience of a visual scene is built up over many small, very local eye fixations. Each foveal fix captures only a tiny patch of the visual field, subtending a few degrees of visual arc. To become conscious with high resolution of an ordinary scene, the visual brain must integrate many of those local fixations into a single, stable, meaningful whole. It is therefore essential that each fixation be aimed accurately at the most informative targets in the visual field.

But eye movement control is plainly *not* the same as visual consciousness. Not only do the brain regions for these tasks differ, they are conceptually as different as night and day. Eye movements *select* certain regions of a visual scene for detailed analysis, while color perception, edge detection, motion analysis, and the like go to build up a certain conscious visual experience. We move our eyes *in order to* see something; the result of a selective movement is a particular conscious sight.

This point generalizes to selective operations across the board. If attention is broadly defined as those operations that select and maintain conscious events, we can apply that definition to selective mechanisms in all sensory modalities, to memory operations, to the ''mind's eye,'' and even to language and thought. Attentional mechanisms may be said to select conscious events in all these domains.

2.1. Operational Distinctions between Attention and Consciousness.

Selective attention and consciousness are distinct operationally as well. Attentional operations include instructions to attend and disattend, effortful control of attention against competing input, and experimental manipulations of attentional selection priorities, by means of electric shock conditioning, for example. All these operations influence the likelihood of selection of certain experiences. There are also uncon-

scious selective operations, such as the unwanted dominance of word-meaning over word-color in the Stroop effect.

In contrast, our most obvious index of consciousness involves people describing their experiences in some verifiable way, under conditions that maximize accuracy. This index has pros and cons, like any other. The traditional term ''verbal report'' is actually rather misleading. Verbal report seems to suggest a visible, physical act, as if the essential thing is the movements of jaw and lips and vocal cords. It is focused on the behavior. I would rather call it *experiential report*, just to be completely honest about the fact that it *is* always a claim about our experience; that is how people understand it, and when scientists adopt a first-person perspective, that is how we understand it too. Whole fields such as perception and psychophysics depend upon experiential reports and have for a hundred years. They have led to impressive scientific results. Almost everything we know about sensory processes, imagery, and immediate memory is based on this evidence, which is entirely different from the evidence for selective attention described above.

Conscious experiences can be reported in many ways. We can use speech or writing, sign language, pointing, even an expressive roll of the eyes. These are all voluntary, communicative acts that are used to report conscious contents. For instance, voluntary eye movements were the behavioral index of choice in the remarkable discovery of lucid dreaming by Stephen LaBerge, William Dement, and colleagues at Stanford University (LaBerge, Nagel, Dement, & Zarcone, 1981). In dreams incoming sensory events are largely blocked and voluntary muscles are mostly paralyzed, except for the eye and breathing muscles, which are free to move. LaBerge and Dement were the first to show that dreamers can signal their awareness of a tone by way of voluntary eye movements. Given an auditory signal, subjects in REM sleep can move their eyes intentionally back and forth several times, count to 10, and then signal the end of the interval with another set of eye movements. This remarkable ability supports the hypothesis that dreaming involves a kind of conscious state.

Any agreed-upon voluntary action can signal a particular conscious experience. Verbal report is not necessary. In daily life we can comment on a television program, for example, with an exasperated glance, a grunt of boredom, or simple rapt attention. These actions communicate aspects of our experience as surely as verbal descriptions do.

In sum, we routinely infer the existence of particular conscious experience, when:

(a) it can be communicated through some voluntary signal;
(b) it can be verified;
(c) it is claimed to be conscious, whether explicitly or not; and
(d) reporting conditions are optimal.

Again, the empirical criteria for attention are entirely different.[2]

[2] One source of possible confusion involves the fact that conscious contents can trigger selective attention as well. This is traditionally called ''voluntary attention'' and includes everyday examples such as decisions to attend to a difficult topic or task, or instructions to attend to an experimental stimulus. Thus consciousness interacts with attentional processes in two directions. Notice, however, that even in

TABLE 1
Widely Studied Polar Terms Involving Conscious and Unconscious Processes

Associated with consciousness	Associated with unconsciousness
1. Explicit learning and memory	1. Implicit learning and memory
2. Immediate memory	2. Long-term memory
3. Novel, informative, and significant stimuli	3. Routine, predictable, and nonsignificant stimuli
4. Attended input	4. Nonattended input
5. Focal contents	5. Fringe events (feelings of familiarity, knowing, etc.)
6. Declarative memory	6. Procedural memory
7. Supraliminal stimulation	7. Subliminal stimulation
8. Effortful processes	8. Spontaneous/automatic processes
9. Remembering	9. Knowing
10. Available information	10. Unavailable information
11. Strategic control	11. Automatic control
12. Terminal strings in implicit learning	12. Inferred structure in implicit learning
13. Intact reticular formation and intralaminar nuclei	13. Damaged reticular formation and intralaminar nuclei
14. Rehearsed item in working memory	14. Unrehearsed items in working memory
15. Wakefulness and dreams (rapid EEG)	15. Deep sleep, coma, sedation (slow EEG)
18. Explicit inferences	18. Automatic inferences
19. Episodic memory	19. Semantic memory
20. Autonoetic memory (Tulving)	20. Noetic memory

2.2. Treating Consciousness as a Variable

Consciousness as a variable of interest can be studied most directly by comparing closely matched conscious and unconscious processes.[3] Table 1 shows 20 matched conditions that are currently seeing intense scientific exploration. These polar pairs naturally fall into two large groups that can be labeled ''conscious'' and ''unconscious;'' yet the relevance of these 20 standard polarities to the foundation issue of consciousness is not always made clear. I have called such very close paired comparisons ''contrastive analysis,'' based on a direct analogy to linguistic methods (Baars, 1983, 1988, 1996). Contrastive analysis is of course a generalization of the experimental method, allowing us to treat consciousness as an empirical variable. Any

the case of conscious experimental instructions, the detailed process of selection and maintenance of conscious focus is largely unconscious.

[3] We need unconscious comparison conditions to study conscious *as such.* Unconscious processes can be reliably established when some known event: (a) is claimed not to be conscious and (b) cannot be reported or acted on, (c) even under optimal reporting conditions, but (d) whose presence can nevertheless be verified.

By this definition, automatic processes are unconscious, as are blindsight, unattended information, subliminal priming, the details of sentence analysis, and so on. There is again a good fit between this definition and existing scientific practice. If we hold a pair of scissors before the eyes of blindsight patients, they would claim not to see anything, yet they might be able to reach for the scissors with thumb and forefinger extended to insert into the scissor loops. Thus we can verify that some part of the visual brain knows about the scissors, though the patient disclaims any direct perceptual knowledge. There is a dissociation between what the brain knows and what the patient claims to experience.

adequate theory of consciousness must account for the full set of contrastive pairs, which is quite large. Theoretical claims about consciousness are therefore highly circumscribed by robust and reliable evidence.

2.3. Applying the Distinction: Conscious vs. Selective Components of Posner's Visual Attentional Network

To illustrate the distinction between consciousness and attention in scientific practice, we can reinterpret Posner's ''visual attentional network'' in terms of its attentional and experiential aspects (Posner, 1994; Posner & Raichle, 1994). Based on a variety of experiments using PET scans, lesion studies, and other means, Posner has amassed a good deal of evidence from PET scans and other sources, indicating that several locations in the cortex are closely involved in visual attention, broadly defined. Can we usefully distinguish between the conscious and the selective components of Posner's network? The answer is quite easy. The selective attention/conscious-experience distinction is in fact articulated in Posner's work, though the term attention is used both for selection and as an umbrella term to denote the entire project. Thus Posner (1994, p. 7399) writes that the first working assumption of the cognitive neuroscience of attention is that ''There exists an attentional system of the brain that is anatomically separate from various data-processing systems that can be activated passively by visual and auditory input.'' Note that the latter are usually thought to involve visual and auditory consciousness. The attentional system is therefore separated from consciousness from the very start. It carries out at least three functions, ''orienting to sensory stimuli, particularly locations in visual space; detecting target events, including ideas stored in memory; and maintaining the alert state.'' Again, at least the first two functions appear to be selective in nature.

''Switching visual attention'' is clearly a selective act, which Posner associates with parietal cortex acting via the pulvinar nucleus. The effect of attentional switching is to amplify the firing rate of sensory neurons, those that are ultimately experienced consciously. Others have suggested that temporal coordination of the increased firing rate is also necessary for conscious sensory experience.

A second system involves ''executive attention.''[2] Executive control over selective processes involves the anterior portion of the cingulate gyrus, with other frontal cortical input. This is traditionally called ''voluntary attention,'' because it may involve, for example, instructions to attend to a particular target, or to particular aspects of a target, like its color, shape, or location. This attentional system is also quite separate from brain areas supporting sensory consciousness.

It is the visual projection areas in occipital and ventral temporal cortex that most persuasively support visual consciousness itself. There are four sources of evidence for this claim. First, when the first visual projection area (area V1) is lost, people report a loss of visual conscious experience, though they can still accurately ''guess'' the objects that their eyes are looking at. This is the famous case of blindsight that has been studied by a number researchers for many years (e.g., Weiskrantz, 1986; Stoerig and Cowey, 1989). In addition, selective damage to higher visual areas results in loss of other specific levels of conscious experience, such as motion perception, color, and face recognition. However, only V1 seems to subserve the entire conscious

aspect of vision, distinct from unconscious visual processes. Second, when the early visual areas are stimulated by a low current, people report conscious visual flashes (phosphenes); stimulation elsewhere does not show this effect. Third, when people are conscious of a visual object, we can now see the early visual areas ''light up'' in brain scans, indicating a distinct, local increase in neural activity (Posner & Raichle, 1994, p. 71). Finally, groups of single cells in visual cortex closely track the conscious flow of visual stimulation in a binocular rivalry task at levels V1, V2, V4, and MT. The unconscious flow also evokes neural firing, but the two streams of information can be tracked separately from each other (Logothetis & Schall, 1989; Leopold & Logothetis, 1996). Together these four sources of evidence support the hypothesis that the early visual projection areas are critical for visual consciousness. None of these facts apply to the other attentional areas described by Posner and colleagues.

We could not make sense of these findings without making a clear distinction between attention and consciousness. It is a distinction that fits common sense as well as a large body of scientific findings. And now we know it also fits recent findings based on brain anatomy and physiology.

2.4. Does ''Limited Capacity'' Apply to Consciousness or Attention?

Consciousness is widely viewed as one aspect of the limited-capacity system, which also includes attention, immediate memory, and voluntary control. Limited capacity mechanisms constitute the interface between the brain and the world, and they can be contrasted with the unlimited capacity of memory systems and other unconscious knowledge sources, and indeed the vast capacity of the brain itself. The case can be made that the core limits on this system are specifically due to the fundamental features of consciousness. Thus the most distinctive aspects of human information processing may be due to consciousness rather than other commonly associated constructs.

That point is easily made with respect to selective attention, if we follow the distinction made above between attention as a selective capacity and consciousness as an experiential one. Selective mechanisms can be quite unconscious, and there is no reason to think that they are constrained by the classic seven plus or minus two limits on immediate memory. At any single moment selective control of conscious contents is influenced by a host of factors, motivational, memory-based, environmental, sensory, orienting habits, personal and biological relevance, etc. In neural terms, the vast number of regions that can influence eye movement control (as one concrete example of a selective system) suggests multiple simultaneous constraints. In contrast, each of the seven plus or minus two items of classical short-term memory is immediately available to consciousness. Considerations like this suggest that the real capacity constraints may be on conscious contents. From a perceptual point of view, in fact, we are limited not to seven, but to only a single, coherent stream of perceptual information at any given moment.

3. A DISTINCTION BETWEEN CONSCIOUSNESS AND WORKING MEMORY

If we can tease out attentional mechanisms from conscious mechanisms, what about working memory? Baddeley (1992) recently wrote that ''. . . any model of

human memory that leaves out the issue of conscious awareness would be incapable of dealing with much research.'' Consciousness, he suggested, ''. . . is a means of coordinating information from a number of sources, including the present, specific episodes from the past, and projections as to the future. . . . [It] *operates through working memory*. . . . [I]ts crucial function is that it allows the organism to reflect on the available options and choose a particular action or strategy, rather than being driven by the sheer weight of past experience.'' [Italics added]

The conscious element in WM has traditionally been called the ''active element.'' This terminology dates to a time when researchers were reluctant to speak of consciousness. Today, we can speak more freely about the WM elements people can report as conscious, using the operational criterion discussed before. The result of acknowledging human experience is theoretically significant. Consciousness is evidently involved in all WM input, output, and voluntary operations, as in explicit problem solving (Baddeley, 1992; Newell & Simon, 1972).

Is working memory the basis of conscious experience, or vice versa? The present paper argues that WM may be a superstructure dependent on the fundamental features of consciousness. Crick and Koch (1990) have argued for ''working awareness,'' in which presumably WM depends upon awareness, and Baars (1988) has shown that a Global Workspace (GW) model of conscious functioning can handle the functions normally assigned to WM. GW theory argues, however, that consciousness itself involves a kind of workspace.

4. A DISTINCTION BETWEEN PERCEPTION AND CONSCIOUSNESS

Sensory perception has robust conscious qualities, what philosophers call *qualia:* color, texture, taste, smooth and rough touch, wetness, sharp and dull pain, and so on. Perceptual awareness may be the most ancient mode of consciousness, since the sensory systems are evolutionarily old. Nothing in human experience is as rich and full of subtle details as the sensory world. But sensory perception is not the same as consciousness.

There are two arguments for making a clear distinction between them.

First, there are conscious contents that are not perceptual. Vivid mental images or inner speech are not externally driven, though they often show sensory qualities; and in everyday speech, reportable concepts, beliefs, or intentions are also considered conscious. Philosophers have long argued that consciousness of percept-like events differs from consciousness of abstractions. Abstractions, such as the meaning of ''mathematics,'' do not involve sensory qualia, except as an incidental association perhaps. Finally, clear, reportable, and accurate intentions are also conventionally considered to be conscious. Thus many different kinds of contents can be conscious; perception is only one. This is one argument against the idea that consciousness can be reduced to perception.

A second argument for the distinction is based on evidence for unconscious sensory input representations. Sensory perception involves stimulus representation, but Table 2 shows a dozen different kinds of stimulus representation that are not conscious. Thus perception and consciousness cannot be the same.

In sum, the three constructs that are often conflated with consciousness—attention, perception, and working memory—can be dissociated from it, both operationally and

TABLE 2
Perception: Contrasting Conscious and Unconscious Stimulus Processing

Conscious events	Comparable unconscious events
1. Perceived stimuli	1. Processing of stimuli lacking in intensity or duration, or centrally masked stimuli 2. Preperceptual processes 3. Habituated or automatic stimulus processing 4. Unaccessed meanings of ambiguous stimuli 5. Contextual constraints on the interpretation of percepts 6. Unattended processing of perceptual input

conceptually. Making those distinctions is helpful to clear thought. When we reanalyze existing evidence in light of these considerations, many of the features usually attributed to perception, working memory, or attention turn out to apply to the conscious aspect of these constructs only. As a result, we have far more evidence about consciousness than is usually supposed.

5. A THEORETICAL INTERPRETATION: CONSCIOUSNESS CREATES ACCESS TO UNCONSCIOUS RESOURCES, WHILE ATTENTION CONTROLS ACCESS TO CONSCIOUSNESS

The central theoretical claim made here is that attention creates access to consciousness. But why bother to do that? I have suggested elsewhere that consciousness is needed to create access to unconscious processing resources such as the lexicon, autobiographical memory, action routines, and even specific neurons and neural populations (Baars, 1988, 1996). Thus consciousness is the publicity organ of the brain, one that is used to access all of its functions. If this is the case, then attentional mechanisms exist to control access to this publicity organ, the bright spot on the stage of consciousness.

If this is true, attentional selection may be needed for at least two reasons.

(1) To control the allocation of resources by directing unconscious knowledge systems toward significant stimuli and problems, making them conscious in proportion to their informational and motivational significance. Some examples include paying attention to significant personal and biological events; the resistance of significant stimuli to habituation from awareness; and our tendency to pay more attention to problems that demand more novel solutions. If humans lacked access control for consciousness, we would be unable to cope with unexpected emergencies or opportunities.

(2) Regulating the flow of novel information, so that we do not confront either too much or too little novelty. Excessive novelty can be overwhelming. Excessive redundancy wastes mental processing capacity. The nervous system must find a balance between the two, and selective processes may operate to optimize that balance.

6. CONCLUSIONS

This paper has attempted to tease apart the theoretical construct of consciousness from three other constructs that are often conflated with it: attention, working mem-

ory, and perception. This is possible if we can treat consciousness as a variable, that is, if we can find comparison conditions between closely matched conscious and unconscious processes to focus on consciousness as such; and then separate this dimension from the defining conditions of selective attention, perception, and working memory. In the case of attention, selective processes are already separated from conscious sensory processes in the brain (e.g., Posner, 1994), and it is merely a matter of using the terms with greater consistency. In working memory, there is a long history of separating the ''active element,'' which also turns out to be the conscious element. In the case of perception, we know of many examples of stimulus analysis and representation that are not conscious, so that again we can dissociate the essential function of perception from consciousness. Finally, an interpretation was offered of the relationship between attention and consciousness in creating access to unconscious knowledge and control sources.

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